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COLE ON "HEREDITY"

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HEREDITY AS WE SEE IT TODAY

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We live in a world of constant change. The phenomena of growth and decadence are everywhere about us. Particularly in biology are we daily brought face to face with prenascence, birth, adolescence, senescence, and death. The dust of the dead furnishes material for the new, and so progress is made.

And so it is with our scientific theories and even the broader disciplines of our science. The germ of an idea incubates for a period and finally comes to light as a new hypothesis. Yet not entirely new. "*Omne vivum ex ovo*," said Harvey. And just so the new hypothesis; if examined closely, it will doubtless be found that the germinal idea was but the potential reproductive body left by a previous generation, fertilized belike by union with a related idea which not only served as activator but at the same time furnished those new elements that provided for something different from what had been before. In examining our present-day ideas of heredity, therefore, what can be more profitable than to look into the genesis of the new science of Genetics, which deals with the laws of heredity? Let us pry into its beginnings and see what elements came together to give it being; and how it has grown and developed through a more or less precarious childhood, until now it stands strongly on its feet as a science among the sciences—a full-grown and vigorous youth in the biological family. But one to grow and develop properly must have proper nourishment and propitious surroundings, that is to say, a suitable environment. Under what conditions has Genetics developed and what factors have contributed to its growth? Where is it now in its life span? Is it still in its adolescence or has it fully matured? May it even perhaps be past its prime and beginning to

show the disintegrative signs of old age? If it has much of its life still ahead, shall we be able to predict something of what it will be and the course it will take?

Furthermore, no individual can live entirely unto himself. His life must interact with and influence the lives about him as well as be influenced by them. And so in such time as we have let us inquire what influence Genetics has had or is likely to have on the other sciences with which it is associated.

The Older Ideas of Heredity

As soon as man gave thought to anything about him, he must have remarked the common resemblance of children to their parents and of children of the same family to one another. He likewise observed the same phenomenon in his flocks and with his corn. The admonition that "whatsoever a man soweth, that shall he also reap," while used figuratively, was nevertheless based on literal knowledge. "Do men gather grapes of thorns, or figs of thistles?" Obviously not.

The Scriptures are replete with references to inheritance. It was recognized that the child is in some way a living part of its mother and its father but just what the continuity is, and what determines the degree of resemblance or of difference was a matter of mystery. It is true there were ideas as to ways in which heredity might be influenced, as exemplified by Jacob's scheme to load the dice in his favor in his bargain with his father-in-law, but these were for the most part fanciful and had no real basis of fact. It is a striking fact that these same ideas of heredity persisted almost up to the present century; in fact, they are still largely prevalent even today among the less well-informed and certain of them yet from time to time find their way into our popular press. Neither Greek nor Roman learning made any real contribution to a scientific explanation of the laws governing inheritance, nor did any other culture for that matter. It is true that experience of what might be expected of certain parental combinations, combined with more or less valid theories based to some extent on such experience, led to a high development of the art of breeding, both of animals and of plants. This was a purely empirical art, however. Such rules as were formulated were merely attempts to describe observations of so inconstant and variable a character that they were of very indifferent reliability. They contributed little more than fancy as to the causes of filial resemblances and differences.

In most text books of breeding as late as the first decade of the present century the rule that "Like begets like," or, a little more cautiously phrased, that "Like *tends to* beget like," was stated as the first great law of heredity. This latter formulation may be accepted as a natural law, in that it describes a relation which exists with regard to certain natural phenomena; yet it is so general in its inclusiveness that it is of little value for the purpose of prediction. The colloquialism used to express a resemblance of a son to his father, when we say, "He is a chip off the same block," expresses the same idea but carries a further implication, namely, of physical continuity between the two generations and to some extent at least, of identity of one with the other. The great problem of heredity obviously is to determine how much identity there is and just what determines in a particular case what the exact resemblances and differences will be. Heredity, therefore, hinges on the nature of that bridge of material existence which connects one generation with the next.

The First Step

The first great step toward an adequate understanding of the relation between generations came with a more adequate knowledge of the facts of embryology. As Woodruff says, "It is but natural that the study of inheritance could be little more than a groping in the dark until embryology, under influence of the cell theory, afforded a body of facts which clearly indicated that the fertilized egg is typically the sole bridge of continuity between successive generations."

The fact that many animals, such for example as birds and fishes, arise from eggs laid by the mother was obvious even to the ancients. It was also realized that the contribution of the male played some part in the process, but what that part might be was far from understood. The fact that all animals so arose was far from generally believed, however. Aristotle saw no incongruity in the idea that eels arose from slime and it was generally accepted that maggots generated spontaneously in decaying organic matter until Redi in 1668 proved by the experimental method that no larvae would develop in decaying meat unless the adult flies could gain access to deposit their eggs. Not until the classical bacteriological work of Pasteur and Koch two centuries later, however, was the theory of spontaneous generation abandoned for even the simplest organisms.

The crude ideas of zoölogical relationship and heredity that existed

during this earlier period are illustrated by the notions of the transmutation of species, that is, the origin of one kind of animal from another. With the scant knowledge of the time, however, it perhaps seemed no more remarkable that geese should arise from barnacles than that a gaudy butterfly should come from a crawling caterpillar.

Scientific advance in a particular line often has to await the development of some instrument or method which will afford an extension of the field of observation. In this respect the invention of the microscope was of the greatest importance to biology. With even the crude instrument of his time, Leeuwenhoek (1678) was able to discover the male germ cell. Shortly before this, Hooke (1665) had described the "little boxes or cells" he had seen in the structure of cork. Both animal and plant cells were depicted from time to time by the microscopists of the seventeenth and eighteenth centuries but it was not until 1838 that Schleiden and Schwann propounded the cell theory, which has justly been termed "one of the greatest generalizations in biology." It established the cell as the universal unit of structure of organisms. This generalization, together with the knowledge gradually gained of the origin and structure of cells and the proof by Max Schultze (1861) that the viscid content of living cells, the protoplasm, is the same in animals and plants, laid the firm foundation for modern biology. Of greatest importance to genetics, it established the ovum and the spermatozoon each as single cell-units and thus brought them into the general scheme. Later embryological researches showed how the individual arises from the fertilized egg merely by the multiplication of these cells by repeated division, their differentiation to form tissues and the gradual establishment of all the organs and parts of the individual by processes of folding and growth.

These findings definitely set at rest such speculations as those of preformation, which resulted from earlier faulty observation combined with imagination. It has already been mentioned that Leeuwenhoek in the seventeenth century with his crude microscope had discovered the male germ cell. In his enthusiasm he imagined he could even discern within the spermatozoon a *preformed* individual which needed only to grow. The requisite nutriment and protection were furnished by the egg and by the body of the female. It is obvious that such an hypothesis gave little thought to the facts of inheritance nor, for that matter, to common sense. The absurdity of the preformation idea is apparent when carried to its logical conclusion:

"Each seed includes a plant: that plant, again,
Has other seeds, which other plants contain:
Those other plants have all their seeds; and those,
More plants, again, successively inclose.

"So Adam's loins contained his large posterity,
All people that have been, and all that e'er shall be.

"Amazing thought! What mortal can conceive
Such wondrous smallness! Yet we must believe
What reason tells: for reason's piercing eye
Discerns those truths our senses can't decry."

The Inception of Genetics—Mendel's Work and Discoveries

Less than a quarter of a century after Schleiden and Schwann announced the cell theory and at about the time that Max Schultze established the universality of cell protoplasm, a Moravian monk working quietly in the scientific isolation of his cloister was providing the key that was later to unlock the door to the long-hidden mysteries of hereditary transmission. Mendel's work is now so generally known that it is almost presumptuous to attempt to explain it. But it was not accorded such recognition when it was first published in the obscure proceedings of the local natural history society of Brno in 1866. The reasons for this we shall see in a moment.

The importance of the cell-theory lay in that it furnished a unit of structure which underlies all plant and animal tissues. It furnishes something definite to work with and has a certain order in its origin and development. Each cell arises from the division of a previous cell, and by gradual diversification, differentiations of the animal and plant structure are brought about. Furthermore, each individual arises from a single cell that was part of a previous individual; it is of the same lineage and consequently resemblance of offspring to parent might be assumed from this genetic relationship.

But the situation is not so simple. In sexual reproduction, as in the higher animals and plants, the new individual does not arise from a single cell derived from one of the parents, but from a cell which represents a combination of the sperm cell of the father with the egg cell of the mother. It is thus dual with respect to its origin, and this is commonly evident in its resemblance to one parent in some of its

characteristics and to the other parent in other respects. Or it may appear to be a blend between the two parents, or perhaps different from either. This could only be explained by saying that in some way the mixture of materials received from the two parents—the two germ plasms—was different in composition and consequently produced a different result from either one alone. But no one could seem to predict what result to expect, to say which offspring should be like one or the other parent or what proportion would resemble one or the other.

It was these questions Mendel set out to answer, and he did so in a remarkably systematic and thoroughgoing fashion. His success is doubtless to be attributed to his acute perception of the problem, his choice of material to work with, his painstaking industry and care, and his mathematical insight. After attempts with other material, he chose garden peas for his experiments. These proved to be especially favorable for a number of reasons and Mendel was fortunate in his choice. The high points in his work and discoveries may be briefly summarized:

First, he realized that analysis of the inheritance could be made only by the crossbreeding method; only by bringing into the fertilized egg different potentialities could the characters which those potentialities represented be followed in the offspring. Thus if one parent plant had green pods and the other yellow, it would be possible that the daughter plant might have all green or all yellow pods, or there might be some of each; or the pods might be mottled green and yellow, or they might be some different color entirely.

This brings us to the second condition of Mendel's success. He focussed attention on single alternative character pairs at a time. Were the pods yellow or green? Did they remain turgid when ripe or did they become flattened? Were the plants tall or were they short? Did the side branches tend to come out clumped together or were they spread along the stem? Were the seeds yellow or green? Were they round or wrinkled? Were the flowers colored or were they white? Mendel studied all these characters and found the same rules of distribution among the progeny after crossing to apply equally to all of them.

When a cross was made involving any particular pair of the alternative characters mentioned, the first offspring resembled one of the parents to the exclusion of the other. Thus when a plant of a tall race was crossed with a dwarf variety, all the immediate offspring

were tall. This was interpreted by assuming that whatever was brought into the fertilized egg by the tall parent, representing tallness, in some way dominated the contribution of dwarfness from the other parent. That the latter was still there and remained represented though not expressed was demonstrated, however, when a second generation was raised from the crossbred plant. Now in this progeny appeared not only tall again but also short and, what was of the greatest importance, *they were found to reappear in definite proportions*.

Here was where Mendel's mathematical insight came into play. The proportions of the different types of offspring in this second generation were the same as would be expected from the random combinations of any two alternative events, such, for example, as the tossing of two pennies. The reasoning was therefore simple: The crossbred individual contained both hereditary potentialities, for tallness and for shortness, though owing to dominance only one was manifested in the appearance of the plant. When this plant formed its reproductive cells, however, these potentialities—or call them determiners, if you like—for tall and dwarf went separately into equal numbers of different germ cells. Since this is true for the male reproductive elements as well as the female, the chance union of these (fertilization of the ovum) would give the same numerical result as the tossing of two pennies. These two processes are known as segregation, and recombination of the gametes—gamete being a general term including both kinds of germ cells.

Not only did Mendel ascertain that the foregoing behavior was characteristic of all the characters with which he worked, but he further established that each of these pairs behaved entirely independently of the others.

These results were of the greatest significance in relation to theories of heredity. In the first place, the regular behavior, giving results capable of mathematical description and prediction, showed that whatever was responsible for the development of a tall plant, for instance, as contrasted with a dwarf, must be a specific entity of some sort. Furthermore, this entity cannot be the whole cell, since the independent results with the different character pairs show clearly that the reproductive cell carries different and independent entities for each. These determiners, therefore, constitute definite *units* of heredity, which reside within the cell and are transmitted from generation to generation in a definite manner. Their actuality is not based on direct observation, but the breeding results indicate that *something*

must be transmitted in the manner described. Even though they are hypothetical units, therefore, in the sense that the atom is hypothetical, their establishment meant as much to genetics as did the theory of the atom to chemistry or the discovery of bacteria to the understanding of putrefaction and disease. It gave something definite with which to deal.

The times were not ripe, however, for an appreciation of Mendel's important findings. It is true his results were obscurely published and probably did not come to the attention of many biologists of the time. They were known at least, however, to the botanist Nägeli; but Nägeli was busy with his own speculations on the nature of living substance and of heredity and did not appreciate the importance of Mendel's work. We have no reason to suppose that these remarkable results ever came to the attention of Darwin, and it is interesting to speculate as to whether he would have recognized their worth. Personally, I am inclined to believe that he would.

The Prenascence of Genetics—The Era of Darwinism

Curiously enough, Darwin's own speculations, and particularly the publication of the "Origin of Species," only three years after the appearance of Mendel's contribution, was probably an important factor in diverting attention to other lines. This instituted an era of some forty years in which attention in biology was largely focussed on the evidences of evolution. During this period we may say that while there was much speculation as to the manner of inheritance and development, no real advance was made in genetic theory. Nevertheless, researches into the finer structure of the cell were under way, which were of the greatest importance to a later understanding of Mendel's findings, as we shall see. While not in evidence at the time, the new science of genetics was undergoing formative processes which enabled it to grow and develop with startling rapidity when once it came to light.

Refinements of technique, and particularly the use of dyes to differentiate the structures of the cell, early showed it to be more than a simple viscous mass; in reality, a very complex structure. Within all types of cells at certain stages were found certain deeply-staining bodies remarkable for their universality and constancy. Because of their coloring so readily Waldeyer gave them the name of chromosomes, or color-bodies. They were found in the cells of both animals and plants, and while they differed in number, size, and shape

in different forms, within the same species they were remarkably uniform in all these respects.

The most unique thing about the chromosomes, however, proved to be their elaborate behavior at the time of cell division, that is, when a cell by division gave rise to two daughter cells, which as already seen is the universal method of growth and differentiation. As a cell is preparing to divide, the chromosomes move about in systematic fashion and finally line up in a single plane. Each then splits lengthwise and the component halves separate and as the cell itself divides they go respectively into the two daughter cells. This process results, therefore, in each daughter cell receiving exactly half of the chromatin material; it is consequently identical in this respect with its sister cell, and with the original mother cell from which they were both derived.

With each successive cell division this complex process is repeated. Such an elaborate mechanism to divide the chromatin material so exactly obviously indicated that this result must be of great importance and it was a natural conclusion that the chromosomes must be of paramount significance in heredity. Such has later been abundantly proven to be the case. Their importance in this respect was further emphasized when their behavior at the time of reproduction was studied. It has been mentioned that each kind of animal or plant has a definite number of chromosomes, but since the new individual arises from the union of two sex cells, how is this number maintained? Why does it not double at each reproduction? The adjustment is a beautiful adaptation, for at some time prior to the formation of the germ cells, the chromosomes go through a modified preparatory behavior, and as a consequence their number is reduced by just half. The germ cells, therefore, having this reduced number, by their union restore the original full number in the fertilized egg.

Nor is this a haphazard process, for it is found that the chromosomes in the body cells really consist of a double set—the chromosomes are present in duplicate—and when the reduction occurs it is brought about in such a way that the mature sex cell contains a complete single set, that is, it has one representative of each pair of chromosomes. This is a matter of prime importance.

During this period, while detailed knowledge of cell structure and behavior was accumulating, speculation as to the nature of heredity and of development was by no means idle. Time will permit bare mention of two or three of these theories. Nearly all involved the

idea of transmission from parents to offspring of discrete entities or particles of some sort which in some way determined the course of development in the new individual. Darwin, with considerable reservation, suggested his hypothesis of pangenesis. This assumed that development was due to very minute formative-determining particles, the gemmules, which had been set free by the various organs of the parents and aggregated in their germ cells. The fertilized egg thus contains sets of gemmules from both parents which result in a blend or mosaic of the parental characters in the offspring. Furthermore, since the gemmules might be contributed by the adult tissues, it could be assumed that they would be modified by changes of these tissues due to function or environment, thus allowing for the inheritance of acquired characters.

This was succeeded by the theory of germinal continuity, which was especially elaborated by Weismann. Simply stated, this theory assumes that there is a continuous thread of germ-plasm, carrying the complete hereditary potentialities, which passes through and connects successive generations. The individual animal or plant may be looked upon as an outgrowth from this germinal stream or stock, in much the way a new plant grows up each year from a perennial underground rootstock. The germ-plasm does not remain constant from generation to generation, however, because of sexual reproduction, which produces a commingling of germinal lines between each successive generation. The growth of the individual organism was supposed to be regulated by the elaborate distribution of specific determinants of various orders as development proceeded. The central idea of germinal continuity, in a general way, has held its own; but the elaborate structure to account for development fell before the decisive results of experimental embryology.

The Birth of Genetics—The Rediscovery of Mendelism

It is a common experience that when the time is ripe for a scientific discovery or a new theory, it is made almost simultaneously by two or more independent workers. Mendel was in advance of his time and stood alone. It is true there were one or two other plant breeders of about his time who observed facts similar to those on which he based his laws, but they failed to discover the inherent order. His paper was cited by title in one or two bibliographies on plant breeding, but apparently no one took the trouble to look up the original, or, if he did, failed to appreciate its significance. But toward the end

of the century several workers began to "get warm," as the boys say, on the problem, and in 1900 Mendel's paper was brought independently to the attention of biologists by three botanists, together with confirmatory evidence supporting his conclusions. These rediscoverers of Mendelism were Correns of Germany, von Tschermak of Austria, and DeVries of Holland.

The reception now accorded to the facts of inheritance which Mendel had so beautifully established was quite different from what it had been at the time of their publication thirty-odd years before. Mendel had no knowledge of a physical basis in cellular behavior which would account for inheritance as he saw it. In the intervening years, the main outline of the mechanism for inheritance had been elucidated and all that was needed was to show what the product of the machine would be. This Mendel had already found, and the correspondence of the two was too obvious to be doubted; for in the behavior of the chromosomes was found an exact parallel to the behavior of the individual determiners of hereditary characters as Mendel had postulated. This is especially evident in the preparation for the formation of the germ cells. Mendel assumed that the two determiners for a particular pair of characters at this time segregated, each going separately into a gamete or germ cell. Just so with a pair of chromosomes: at the reduction division the two chromosomes of a pair separate, one going to one daughter cell and one to the other, so that each gamete contains only one of each pair. All that is necessary then is to assume that the chromosome is the determiner for the character, or that the determiner is carried on the chromosome, and the observed facts of chromosome behavior are sufficient to explain the results of the breeding experiments.

The Childhood of Genetics—The Search for Mendelian Characters

Among those who appreciated most keenly the importance of the new discoveries was William Bateson, at that time in Cambridge University, and later director of the John Innes Horticultural Institute. Bateson, together with a number of associates, immediately began an intensive program of research to see whether the Mendelian rules held for inheritance in animals as well as in plants. Cuénot in France and Castle and Davenport in this country pushed the studies with animals and it was not long until there was a host of Mendelian workers and a long list of Mendelizing characters in both

animals and plants. It was the real beginning of Genetics as an important branch of biological science.

While the importance of the new discoveries from a biological standpoint was not overestimated, those who saw an immediate solution of all practical breeding problems were unduly optimistic. The fundamental laws of Mendelian heredity were absurdly simple when it is considered how long they had baffled investigators; but the complications which might arise in the interralations of different characters were not appreciated. These, however, soon became apparent. At first there were many cases which appeared not to be susceptible to Mendelian analysis, but as complexity after complexity was unravelled these gradually were brought into line. A consideration of these complications would constitute a course in Genetics, and they cannot be entered into here. It will have to suffice to point out certain relations which have a bearing on the general hereditary concept.

The Adolescence of Genetics—The Development of the Science

It was suggested sometime back that if the individual chromosomes were assumed to be the determiners for the hereditary characters, the mechanism of their behavior would explain the results obtained by Mendel. But it was not long until more Mendelizing pairs of characters were found in certain species than there were pairs of chromosomes. Obviously, therefore, the unit of inheritance could not be a chromosome, but must be something smaller. Next it was discovered, first by Bateson and Punnett working with sweet peas, that all character pairs were not independent in their inheritance as found by Mendel, but that in certain instances characters that went into the cross in combination from one of the parents came out together in the second generation more often than would be expected on the basis of chance alone. It would appear that they were in some way joined or linked together, though not completely so. Nevertheless whatever linkage was found in a certain case seemed to be constant and to be the same whenever the cross was made.

The next step in genetic advance shifts definitely to America, where Professor Morgan and his collaborators started breeding the common little fruit fly (Drosophila), which proved admirably adapted for the work in many respects. Especially favorable was the fact that it could be reared in a small space in large numbers with con-

trolled matings and that it had a short life-span which could be reckoned in days. New facts and interpretations piled up with bewildering rapidity and the geneticist who kept up-to-date was a busy person.

It soon became apparent that linkage of characters was not only occasional, it was the rule. The natural interpretation was that those determiners (or units of inheritance, which had now come generally to be designated as *genes*), which showed linkage with one another and thus constituted a linkage group, were all carried on, or were a part of, the same chromosome. This would account for their association, but it did not explain why different genes in the group should break their association with a definite regularity. The elucidation of this was due to a brilliant induction by Sturtevant. From a careful analysis of the strength of association of the various genes in a linkage group he showed that this could be explained by assuming that they were arranged along the chromosome in a definite and linear order. With this as a starting point it became possible to make "maps" of the chromosomes, on which the genes for different characters are not only represented in their appropriate and fixed order but at their proper relative distances from one another. In this way geneticists are now busy cataloging and mapping the hereditary units of numerous species of animals and plants just as astronomers have long been occupied in cataloging and mapping the stars of the firmament.

One of the most striking things of modern genetics—and one which lends confidence in the soundness of its foundations—is the way in which the results obtained from breeding experiments and the detailed study of the finer structure and behavior of the parts of the cell have each supplemented and corroborated the other. Thus the microscope shows that in Drosophila there are only four pairs of chromosomes and breeding results demonstrate that there are just four independent groups of linked genes, as would be expected. The microscope, again, shows the different chromosome pairs to be of different lengths, and the maps based on breeding evidence correspond with remarkable fidelity to these differences. By microscopic observation it was demonstrated that the sex of the individual is determined by its condition with respect to a particular pair of the chromosomes, and the geneticist finds that the characters of the group identified with this chromosome are distributed in accordance with expectation. Thus in certain crosses it can be predicted with

certainty that all the male offspring will resemble their mother and the daughters will be like their father with respect to a particular character.

Perhaps the most dramatic confirmation of the "chromosome theory of heredity" has been furnished by those exceptional cases in which something goes wrong with the machinery of the chromosomal mechanism. The abnormality may be discovered first by the cytologist examining the cells under his microscope, so that he is able to predict to the geneticist that if he breeds from this material he may expect a certain disturbance in the regularity of inheritance. Or perhaps more often the geneticist finds an exceptional inheritance and he in his turn can predict an unusual chromosome condition. Sometimes the cytologist can actually verify these predictions, while in other cases it may be that the chromosome change is not discernible. This results in the paradox that the geneticist may be able to speculate more accurately on what the chromosome structure actually is than can the one who observes them directly. A few examples must suffice. Bridges, in 1913, found an irregular inheritance of certain sex-linked characters in Drosophila, which led him to the conclusion that in the reduction division of the chromosomes something must have gone wrong so that the pair of "sex chromosomes" (the ones concerned in the determination of sex) failed to separate and as a consequence one germ cell got both of them and the other none. Such an egg with two sex chromosomes fertilized by a normal sperm with only one would now contain three of these chromosomes instead of the usual pair. A year later he was able to announce that this prediction had been directly confirmed by microscopical examination of the cells.

It has been found in other cases that certain characters become separated from the group with which they are normally associated and show a new relationship with another group. From this the geneticist infers that a piece of a chromosome has become detached and has joined to a chromosome of a different pair. Furthermore, he is able to say with great accuracy just where the translocated piece is attached. Such translocations also have been verified in some instances by direct observation.

In still other cases the total number of chromosomes may be doubled, or individuals may occur which have only half the normal number—a single complete set instead of a double set. Or certain ones may be reduplicated and not others. And all these aberrations

admit of prediction as to what breeding results may be expected under such conditions.

The Maturity of Genetics—The Problems of the Future

All the above advance has taken place in little more than the first quarter of the present century and if we look back we shall see it is by no means inconsiderable. A hazy idea of some mysterious force called heredity, which was passed on from generation to generation in a more or less mystical way, has given place to the conception of definite units of inheritance, the genes, which are identifiably associated with certain structures in the cell—the chromosomes—and which occur in prescribed order and position on the chromosome bodies. Not only that, but they are distributed in inheritance—that is to say, they are transmitted to the next generation—in an orderly manner which allows of mathematically precise prediction as to what the characters of the offspring will be. Of course the complex of genes of relatively few species, either of animals or plants, has yet been analyzed with any considerable completeness and the practical application of the principles is limited, among other things, by the incompleteness of this knowledge. Nevertheless we may assert with confidence that the mechanics of heredity, in so far as the transmission of the determining factors from one generation to the next is concerned, has been solved. Details are yet to be added but the essentials of the process are firmly established. Who can say that that is not real progress?

It may be objected that the mystery of heredity remains, however, as great as before since, beyond designating the genes as "hypothetical units," nothing has been said as to what they really are, how they arise, nor in what manner they act to reproduce an organism like that from which they came. But it is a truism that science cannot really solve the mysterious, it merely pushes it back a little farther, step by step. The unknown, and perhaps the unknowable, always remains. It cannot be denied, however, that genetics has made a great stride. The next step it has to take is the solution of the questions that have just been asked. The forces are now being marshalled for an attack on these problems; in fact, some advance has already been made. Let us consider each of them very briefly.

First, what is a gene? We have found that it is something which is definitely localized and must be very stable, as it retains its identity through untold transfers from generation to generation. Presumably

therefore it is of the nature of a particle, and it has been suggested that it is perhaps a specific, complex, organic molecule. This appears reasonable enough. Jennings has compared each cell to a chemical laboratory in which the different chemicals are arranged in definite series. The chromosomes may represent the shelves and the genes are the different reagents arranged along the shelves in a prescribed order—though not a very logical one, it must be confessed. Unfortunately, in our cell laboratory, the individual chemicals cannot be taken out and analyzed separately; we can only speculate as to their nature from what they do. It has been suggested that, in some cases at least, the gene is of the nature of an enzyme, or chemical activator, but there are difficulties in the way of acceptance of this interpretation. For present purposes they may be defined as specific integral living units capable of indefinite reproduction, their exact nature not being known.

The second question was, how do the genes arise? Where do they come from in the first place? It is often tritely said that they arise by mutation, that is, a heritable change in the germ plasm. It is as if one of the chemicals on our shelf should suddenly change in composition so that it no longer reacted with other chemicals as it did before but produced a different result. Or a bottle might fall off the shelf completely and be lost. The effect is the same in either case—the laboratory would be hampered in its operation by the absence of this reagent, at least in its original form.

Until recently it has been assumed that these changes occurred "spontaneously," which is merely using a word to cloak our ignorance. Very recently, however, it has been found by Muller and other workers that mutations may be produced by exposing the germ plasm to the action of radiation, particularly X-rays. It has been suggested that the germ plasm of all species may be exposed at times to radiation emanating from radio-active earth deposits or even to the recently demonstrated cosmic rays, and this may account for the mutations that seem to arrive spontaneously. Experiments by Babcock and Collins in California and of Hansen in certain mines in Colorado seem to give some basis for this idea but it is doubtful if these can be the only causes. Whatever their original cause, once produced, they are inherited and transmitted according to the Mendelian laws.

And now the last question, how do the genes reproduce a new organism like that from which they were derived? Here our ignorance is great but the problem is beginning to be attacked with vigor. We

can see that a difference in a gene produces a corresponding and characteristic difference in the end result. Red eyes in Drosophila may change to white, or a tall plant may change to a short, or normal mentality may change to feeblemindedness. That is the observable result, but what is the actual physical difference on which it is based? In some cases we know that the difference may be based on the change of some gland supplying hormones to the circulation, in other cases a particular chemical may fail to be elaborated. The big problem ahead is to discover the bridge that connects the gene with the end result.

And now just a word as to the meaning of the development of genetics in human affairs. Its importance in the general scheme of biological science is evident enough. In particular it is coming now to a point where it is beginning to give a new and most promising approach to the problems of evolution. The theory of natural selection alone has never been a complete explanation for the origin of new species. Genetics seems now on the verge of supplying the facts to complete our knowledge, but this is a long story in itself. If, however, the actual formation of new species has not already been effected, we may confidently look for its accomplishment in the very near future.

Within the realm of plant and animal breeding genetics is already obtaining wide application, particularly in the way of supplying definite short-cuts to the desired end. This is more true in plant breeding than with animals owing to the nature of the material. The geneticist is rapidly coming to be not only a respected but even a necessary ally in practical plant breeding and we may look to see the same situation, though it will come more slowly, with relation to animals.

Finally, as to man himself. What shall he do about his own heredity? Shall he leave that to the caprices of chance while he applies the latest advances of scientific knowledge to his flocks and his crops? That would be an absurdity to suppose, though it would be an equal absurdity to assume that he will put the principles into practice in the same way in his own case that he does with his cattle or his corn. Man will in time be forced to give his serious attention to race betterment, and if eugenics is not in the meantime thrown into disrepute by its overzealous and incautious advocates it is destined to become one of the foremost concerns of the human race. When that time arrives perhaps on the head of the geneticist of

today who is working away with pick and shovel to extract his small share of precious ore there may fall a correspondingly small ray of glory. That and the satisfaction of the work in itself seem about all he is likely to receive in the way of reward.

LIST OF MISSING PERSONS

Can You Help Us Locate These Members?

Name	*Chapter*	*Last Known Address*
Branson, De Hillik	Missouri 1916	Dept. Exten. Courses, Kansas Agricultural College, Manhattan, Kansas
Braudner, Alexander Rudolph	Illinois 1913	835 Kings Road, Hollywood, Calif.
Brechner, Claude	Mich. 1911	Service Motor Truck Company, Manchester Avenue, Wabash, Indiana
Breckenbridge, Clarence Edward	Cornell 1900	Box 114, Reno, Nevada
Breed, Frank	Cornell 1911	3921 Forest Avenue, Kansas City, Mo.
Breithaupt, Erwin Millard	Ohio 1923	2026 N. Fourth St., Columbus, Ohio
Brenton, Benjamin F. P.	Minn. 1910	
Brezner, Barnet	Mich. 1921	528 W. Allegan Street, Lansing, Mich.
Bridge, A. F.	Calif. 1912	2654 Halldale Avenue, Los Angeles, Calif.
Briggs, Robert W.	Columbia 1911	20 Rollins Street, Yonkers, N. Y.
Brinkmann, Heinrich Wilhelm	Stanford 1920	96 Avon Hill, Cambridge, Mass.
Bristol, Leverett Dale (Dr.)	Syracuse 1913	Cattaraugus, New York
Broady, Pell	Neb. 1925	Univ. of Neb. Coll. of Pharmacy, Lincoln, Nebraska
Brock, Lois H.	Calif. 1924	495 Carl Street, San Francisco, Calif.
Broockmann, Oscar W. R.	Columbia 1912	
Brooks, Raymond Ernest	Purdue 1927	271 N. Grant Street, W. Lafayette, Indiana
Brosseau, Conrad Leodore	Purdue 1917	c/o Anderson Meyer & Company, Shanghai, China
Brother, George H.	Neb. 1913	Redmand Chemical Products Co., Chicago, Illinois
Brotherton, Wilber Esmond, Jr.	Mich. 1919	Bureau of Plant Industry, Washington, D.C.
Brown, Albert Marion	Washington 1912	Dept. of Biology, St. Louis University, St. Louis, Mo.
Brown, Arthur Robert	Brown 1905	42 Woodstock Street, Clarendon, Va.
Brown, George Franklin	Mich. 1913	Okmulgee, Okla.
Brown, Harold Duke	Cornell 1923	Cornell University, Ithaca, N. Y.
Brown, John S.	Columbia 1923	
Brown, Joseph Ellsworth	Penn. 1923	4544 North 10th Street, Philadelphia, Pa.

Brown, Junius Flagg	Yale 1925	Denver, Colorado
Brown, Mary Jane	Washington 1921	
Brown, Newton H.	Ohio	Bayonne, New Jersey
Brown, Ralph A.	Cornell 1913	
Brown, Robert Wesley	Chicago 1925	4253 Gladys Avenue, Chicago, Illinois
Brown, Wallace	Colorado 1926	Univ. of Colorado, Boulder, Colorado
Brown, W. Horatio	Minn. 1924	112 S. E. Church Street, Minneapolis, Minn.
Brown, William Lee	Chicago 1912	1410 East 68th Street, Chicago, Illinois
Browne, Edward Tankard	Chicago 1920	Colonnade Club, University, Va.
Browne, K. C.	Columbia 1910	
Browne, Spencer Cochran, Jr.	Calif. 1906	43 Exchange Place, New York City
Browning, Robert M.	Iowa 1916	
Brumer, Milton	Rens. 1924	N. Y. & Queens Co. R. R. Co., Woodside & Jackson Aves., Woodside, N. Y.
Brun, Clement Benjamın	Cornell 1890	310 W. 100th Street, New York City
Brunel, Roger F.	Syracuse 1907	Vassar College, Poughkeepsie, N. Y.
Brunschwig, Alexander Eichel	Chicago 1924	Rush Medical College, Chicago, Ill.
Brunting, Elmer Newman	Chicago 1916	
Brush, Merle B.	Iowa 1927	State Univ. of Iowa, Iowa City, Iowa
Bruton, Fred D.	Missouri 1914	Guthrie, Mo.
Bryden, Douglas Miller	Washington 1921	
Buchanan, LaForest Lee	Iowa 1916	Salon, Iowa
Buck, Ruth	Ill. 1923	705 Indiana St., Urbana, Ill.
Bucy, P. C.	Iowa 1927	State Univ. of Iowa, Iowa City, Ia.
Buddin, Walter	Cornell 1915	Cornell University, Ithaca, N. Y.
Buel, Dr. Mary V.	Iowa 1921	115 Bloomington, Iowa City, Iowa
Buell, Mahlon Henry	Mich. 1922	Gass Technical High School, Detroit, Mich.
Buffam, Basil Scott Whyte	McGill 1923	Chemistry Bldg., McGill University, Montreal, P. Q., Canada
Bukowsky, Harry E. (Prof.)	U. of Wash. 1920	Dept. of Eng., Oregon Agric. College, Corvallis, Oregon
Bulatao, Emelio (Prof.)	Chicago 1923	University of Ohio, Athens, Ohio
Bulbulian, Arthur H.	Brown 1927	117 Thayer St., Providence, R. I.
Bunnell, Alexander Sterling	Calif. 1904	2570 Bush St., San Francisco, Calif.
Burby, James Dennis	Mich. 1911	Jackson, Mich.
Burden, Edith H.	Nwstn. 1920	820 Gaffield Pl., Evanston, Ill.

INSTALLATIONS

UNIVERSITY OF OKLAHOMA

The Oklahoma Chapter of the Society of the Sigma Xi was installed on Tuesday, April 8, 1930. The installing officers were Professor G. W. Stewart, President of Sigma Xi, and Professor L. J. Cole, member of the National Executive Committee.

The first event in the day's program was a public address by President Stewart on the subject, "The Chosen." The speaker showed in a most interesting way what the requisites for success are. Classes were suspended for the occasion so that the inspirational address could be enjoyed by the entire faculty and students.

The formal installation took place at 3:30 in the Faculty Club with President Stewart as presiding officer. Ten members of Sigma Xi from Stillwater and Oklahoma City were guests. After a brief introductory talk by the president, the formal petition was read by Doctor C. N. Gould, president of the Oklahoma Sigma Xi Club. Professor Cole then reported the action of the National Executive Committee and of the Annual Convention of 1929 on the petition.

After presenting the Charter to Professor William Schriever, who received it on behalf of the new chapter, President Stewart delivered an inspiring charge to the chapter. He called attention to difficulties which may be experienced and suggested methods of avoiding them. He concluded by outlining the conditions under which the new chapter may hope best to further the spirit of Sigma Xi at the University of Oklahoma. At the symposium and conference which followed both of the installing officers answered, in a detailed and very helpful manner, numerous questions concerning the operation of a Sigma Xi Chapter.

The president then called upon Doctor Gould to present the report of the Committee on Nominations, which was as follows: For president of the Chapter, Doctor William Schriever; for vice-president, Doctor Alma J. Neill; for secretary-treasurer, Doctor L. E. Swearingen. A unanimous ballot was cast for the new board of executive officers. Upon being called to the chair, President Schriever expressed the appreciation of the group of petitioners of the award of the chapter and pledged the chapter to promote, in every possible way, the spirit of research in the university. After adopting the report of the Committee on Constitution and By-Laws, which was

presented by Doctor Gould, the chapter gave a unanimous vote of thanks to the installing officers for their services, and then adjourned.

The annual Sigma Xi dinner, honoring the installing officers and guests, was held in the Faculty Club at six o'clock, after which the brief toast list was presided over by the president of the chapter. The first speaker, Doctor W. B. Bizzell, President of the University of Oklahoma, brought the greetings of the university to the new chapter. Doctor C. N. Gould, Director of the Oklahoma Geological Survey, responded for the chapter, and President Stewart for the Society of Sigma Xi.

The first public meeting of the Oklahoma Chapter of Sigma Xi was given over to a lecture on, "Heredity as We See It Today," by Doctor L. J. Cole, Professor of Genetics at the University of Wisconsin. This interesting and instructive lecture, which was held in the Engineering Auditorium at 8:15 o'clock, was illustrated by beautiful lantern slides.

Important additions to the regular program took place on the preceding day when both of the installing officers lectured to special groups on their own important recent researches. Professor Stewart gave an illustrated lecture on "The Nature of the Liquid State" to a large audience in the main physics lecture room at the time of the regular Physics Colloquium. Professor Cole talked to a large group of biologists at the same hour in the main zoölogy lecture room on "Hybridization and Sex-Determination in Pigeons." Both lectures were enthusiastically received.

L. E. SWEARINGEN, *Secretary*

STATE COLLEGE OF WASHINGTON

The sixteenth and last business meeting of the Sigma Xi Club of the State College of Washington was held in the reception room of the Home Economics Building, April 14, 1930. The meeting was called to order by Dr. L. J. Cole of the University of Wisconsin, member of the National Executive Committee and officially designated installing officer for the new chapter.

The petition of the Club for a chapter of Sigma Xi at the State College of Washington was read by the secretary.

Professor Cole announced the action of the convention in granting the petition.

The installation address was given by Dr. Cole who declared the State College of Washington Chapter of Sigma Xi installed. The charter was presented to the president, Dr. F. D. Heald.

A symposium followed the installation ceremonies. The portion of the national constitution pertaining to grades of members was read by the secretary. A paper was given by Dr. Vandecaveye on "Standards." Another was given by Dr. Pickett on "Chapter Activities."

The nominating committee proposed the following names: Dr. F. D. Heald, for president; Dr. C. I. Erickson, for vice-president; and Dr. R. W. Gelbach, for secretary-treasurer. The nominations were accepted and the secretary cast a unanimous ballot for each officer.

The constitution and by-laws of the Sigma Xi Club with certain additions to conform with the national constitution were adopted.

The meeting adjourned for the installation dinner at the Commons.

The adjourned meeting was called to order by the president.

The nominating committee proposed the name of Dr. C. C. Todd to be elected as a member of the executive committee, and the secretary cast a unanimous ballot for Dr. Todd.

The Committee on Nominations was elected as follows: C. I. Erickson, H. E. Phelps, F. L. Pickett, Evelyn Roberts, and S. C. Vandecaveye.

RALPH W. GELBACH, *Secretary*

UNIVERSITY OF WYOMING

Professor L. J. Cole of the University of Wisconsin, and a member of the Executive Committee, was the installing officer for the Wyoming Chapter.

The installation meeting was set for two o'clock in the reception room of the Men's Dormitory. This is a large, spacious room, elegantly furnished and beautifully decorated. There is a large fireplace at one end over which is carved a replica of the famous bucking horse, "Steam Boat Bill." A bucking horse being ridden by a cowboy is the insignia, emblematic of the University of Wyoming. This room faces to the west overlooking the campus and the snow-capped mountains of the Medicine Bow Range, fifty miles distant. The room lends itself extremely well to affairs of this kind and the ceremonies as presided over by Professor Cole were very impressive.

Professor E. R. Schierz, president of the Wyoming Sigma Xi Club, called the meeting to order and introduced the installing officer. Professor Philo H. Hammond read the petition of the Wyoming Club. Dr. Pietenpol of the Colorado Chapter responded to the reading of the petition and reported upon the action of the national convention taken upon the petition. Dean John A. Hill, of the College of Agriculture, being the only charter member who was not already a member of Sigma Xi, was then given the pledge and certificate of membership. A very instructive and enlightening symposium was lead by Dr. Pietenpol in which he discussed, "The Purposes of the Society." Prof. John W. Scott of the University of Wyoming discussed the methods of achieving these purposes. Professor A. F. Vass gave a very complete report on private and public activities in which such an organization as ours could function. Professor Cole outlined to the group many things which the future Wyoming Chapter should plan and the work which they would be able to do. The meeting was opened to general discussion where many Sigma Xi questions were raised and answered.

The following officers were elected at the installation meeting and will hold office until the regular annual election of the Wyoming Chapter: president, Aven Nelson; vice-president, A. F. Vass; secretary-treasurer, Cecil Elder.

Dr. Nelson, a national authority in the field of Botany, was made the first president of the Wyoming Chapter largely because of the high esteem in which he is held by his colleagues and associates on the University Campus. Dr. Nelson has been very active in the work of obtaining a charter for the Wyoming group. He was also the first president of the Colorado-Wyoming Academy of Science, an organization, the formation of which was largely promoted by members of the Wyoming Sigma Xi group.

Dr. L. W. Durrell of the Colorado Agricultural College and the present president of the Colorado-Wyoming Academy of Science attended the installation ceremony and gave a short address at the meeting. Twenty-eight members and associates now on the University of Wyoming campus were present at the installation program. Among the guests attending the meeting, in addition to Professor Cole, the installing officer, were Dr. Pietenpol of the Colorado Chapter, Dr. Sterns of the Denver University Club, and Dr. Durrell and Mrs. Durrell of the Colorado Agricultural College, Sigma Xi Club.

The installation banquet was held in the University Commons Building at 6:15. Dr. Aven Nelson, Professor of Botany and President Emeritus of the University of Wyoming, presided as toast master and in a very clever way introduced the following speakers: Dr. A. G. Crane, President of the University of Wyoming; Dr. W. B. Pietenpol, Professor of Physics at the University of Colorado; and Professor L. J. Cole of the University of Wisconsin who gave the principal address of the evening entitled "Heredity as We See It Today." The Honorable Frank Emerson, Governor of Wyoming, was to have been present at the banquet but found it impossible to do so at the last moment.

Every detail of the installation program was well worked out and carried through by an efficient installation committee composed of S. H. Knight, *Chairman*, O. A. Beath, Wilbur A. Hitchcock, and Aven Nelson.

The Wyoming Chapter is now starting out with twenty-five charter members and nine new members and associates who have come to the campus during the year of 1929–30.

CECIL ELDER, *Secretary*

THE UNIVERSITY OF ROCHESTER

Formal installation of the fifty-sixth chapter of Sigma Xi took place on the afternoon of May 3rd, in the Physics Building at the new campus of the University of Rochester. Charter members of the new chapter are those among the University faculty who already were members of the society from other institutions.

Dean Edward Ellery presided at the meeting. After the petition was read, the action of the national organization in granting the charter was announced. The charter was received by Dr. Chambers. Dean Ellery then gave a short talk in which he discussed some of the duties and problems likely to be met with by the chapter, laying special emphasis upon the selecting of members. The chapter then adopted by-laws and elected officers. Dr. Herman Le Roy Fairchild, Professor Emeritus of Geology, by acclaim was elected honorary president. Following the installation tea was served by Mrs. Chambers, Mrs. Berry, and Mrs. Wilkins.

At seven o'clock a dinner for members and friends of Sigma Xi was held at the Eastman dormitory. Dr. Chambers, the President, acted as toastmaster. Dr. Rush Rhees, President of the University

of Rochester, gave a short address of welcome to the new chapter. Dr. Fairchild gave some interesting reminiscences. Dean Ellery, as guest speaker, gave a delightful talk on the history of the Society.

Although active membership in the Rochester Chapter will be confined to University faculty and students, scientists from the several large industries of the city may become affiliated as alumni members. Thus it is expected that the chapter will be an important factor in bringing into closer contact all of the scientific groups in the city of Rochester.

The following are the officers of the Rochester Chapter: *Honorary President,* Herman L. Fairchild; *President,* Victor J. Chambers; *Vice-President,* George W. Corner; *Secretary-Treasurer,* Quentin D. Singewald.

Members of Executive Committee, in addition to the officers, to serve: for one year, T. Russell Wilkins; for two years, Walter R. Bloor; for three years, Hazel M. Stanton.

Committee on Nominations for Membership, in addition to the officers, to serve: for one year, J. Douglas Hood, William Berry; for two years, Harold L. Alling, Irvine McQuarrie; for three years, William S. McCann, John R. Murlin.

QUENTIN D. SINGEWALD, *Secretary*

MINUTES OF THE EXECUTIVE COMMITTEE MEETING, APRIL 28, 1930

The annual Spring meeting of the Executive Committe of Sigma Xi was held at the Cosmos Club, Washington, D. C., April 28, 1930. The meeting was called to order at 9:00 A.M. by President Stewart. Those present were: President Stewart, Secretary Ellery, Treasurer Pegram, Dr. Whitney, Prof. Baitsell, Dr. Wilson, Prof. Lloyd, Prof. Cole, and Mr. Davies.

Business was transacted as follows:

1. REPORTS OF INSTALLATIONS:

Installing officers announced installations as follows:

A. Ellery:	Pennsylvania State College	April 4
B. Stewart:	University of Oklahoma	April 8
C. Cole:	State College of Washington	April 14
D. Cole:	University of Wyoming	April 19
E. Ellery:	University of Rochester	May 3

2. FORMAL PRINTED PETITION:

A formal printed petition from the group of petitioners at the University of Pittsburgh was presented. After consideration, it was

Voted—To present the petition to the convention in Cleveland, December 30, 1930, with recommendation to favorable action.

3. WESTERN RESERVE UNIVERSITY:

Copies of an informal petition were presented from a group at the Western Reserve University.

After consideration, it was

Voted—To appoint an official visitor to confer with the group at this institution for report at some future meeting of the committee. Professor Cole of the Executive Committee was named as the official visitor.

4. QUESTIONS OF POLICY:

Certain questions of policy were discussed as follows:

A. *Distribution of Alumni Funds:*

Mr. Davies, Chairman of the Alumni Committee, reported as follows:

> The Alumni Committee is in general sympathy with the desirability of administering the Alumni Fund so that it will

stimulate research by well-qualified individuals who do not have other facilities or resources.

The committee is of the opinion that any rules that are prepared to guide the Awards Committee in its task should be worked out by the Awards Committee with a view to simplifying the procedure rather than making it more difficult to administer.

It was recommended that the secretary submit to members of the committee a proposed letter soliciting contributions from the alumni and asking for comments.

It was further proposed that chapter officers be asked to make nominations for research grants from the Alumni Fund.

A further suggestion was made that it might be possible to secure larger contributions from individuals for the purpose of research on some special problem.

B. *Suggestions from Chapters Regarding Quarterly and Speakers:*

The secretary reported that a few weeks prior to the meeting, he had sent out 100 letters to officers of the chapters asking, among other things, for suggestions regarding both form and content of the official journal of the Society. At the time of the meeting, six replies had been received, and none contained any comment about the QUARTERLY.

Members of the committee offered suggestions as follows:

1. That an advisory committee be named (with possibly one representative from each scientific field) which committee should be asked from time to time to make recommendations about the official publication.

2. That the papers and lectures delivered at chapter meetings be tabulated according to subject and published in some issue of the QUARTERLY.

3. That the QUARTERLY publish from time to time articles of the progress made in different scientific fields.

4. That chapter officers be requested to designate members of chapters and topics available for meetings of other chapters.

The secretary reported that requests had already been made to chapter officers covering (2) and (4) of the above suggestions and that a future number of the QUARTERLY would contain a report as far as replies from chapter officers make possible.

C. *Official Visitors and Installing Officers:*

It was recommended that the secretary prepare a pamphlet giving in detail:

1. Particular items to be studied by the official visitor at institutions where there were groups contemplating presenting a petition.
2. The customary mode of procedure in chapter installations for the benefit of installing officers.

5. SEMI-CENTENNIAL:

The secretary called attention to the fact that the Society would be celebrating its semi-centennial in 1936, and suggested that a subcommittee of the Executive Committee be appointed to prepare a tentative program for the celebration of that important event—the program to be presented for the consideration of the committee at its December meeting. President Stewart appointed such committee as follows: Ellery, *Chairman*, Stewart, Whitney, Pegram, Baitsell, Davies.

In this connection, Dr. Wilson presented a proposed questionnaire to be sent to all members and associates of Sigma Xi with the purpose of completing our present records of individual members and associates regarding their research work and other activities.

6. DIPLOMAS:

The committee appointed at the New Haven meeting, April, 1929 (Moulton, Ellery, Baitsell, Davies), made a partial report regarding improvement of the present form of certificate for members and associates. After some discussion, it was

Voted—That a Committee on Diplomas be continued and that further report be made at some future meeting. President Stewart appointed a sub-committee on diplomas as follows: Davies, Baitsell, Cole, Ellery.

7. AMOUNT OF ALUMNI FUNDS TO BE DISTRIBUTED FOR THE YEAR 1930–31:

The question of the total sum to be given the Committee of Award of Sigma Xi Research Grants was carefully considered and it was

Voted—To refer the question to the Treasurer with power; but in any case, the sum to be granted should not exceed $5000.

8. COMMITTEE ON AWARD OF RESEARCH GRANTS:

The question was raised as to whether the members of this com-

mittee should be appointed annually by the Executive Committee, or should serve for a longer period. Various opinions were expressed, and it was finally

Voted—That the question of membership of the Committee on Award of Research Grants be referred to the president for report at the December meeting.

9. Basis of Election to Membership and Associateship in the Society:

At the Chicago meeting of the Executive Committee in April, 1928, the secretary presented several inquiries from chapters regarding fields of science which it is the purpose of Sigma Xi to recognize in the choice of members and associates. At that meeting, the committee voted that

"The list of sciences given in the March, 1928, issue of the Quarterly with the addition of Psychology should be accepted as indicating the fields of investigation recognized by Sigma Xi."

The sciences so listed are: Mathematics, Physics, Chemistry, Astronomy, Sciences of the Earth, Biology—in its various branches, including Psychology, Anthropology, Medicine—in its various branches, Engineering—in its various branches.

At the annual convention held in New York, December 28, 1928, the Cornell chapter presented the following resolution:

Whereas, It is not desirable at this time to attempt to define scientific research in terms of either method or subject-matter.

Be it resolved, That noteworthy contribution to (or promise of notable accomplishment in) scientific investigation shall constitute eligibility for election as member (or associate) of Sigma Xi regardless of the field in which the candidate may be working. Each separate chapter shall be responsible for the interpretation of this principle in election of its membership or associateship.

Action was postponed to the annual convention for 1929.

At the convention held in Des Moines, December 28, 1929, after full discussion of the resolution, a vote was passed referring the whole question to the Executive Committee "with power to take such action as in its judgment would best serve the purposes of the Society."

In accordance with action of the Des Moines convention, the Executive Committee discussed the resolution at length and

Voted—That the sciences given in the above list and others closely

allied thereto represent in general the fields of investigation which it is the purpose of Sigma Xi to recognize; that the committee recognizes the distinction between a field of research and a department of instruction in an educational institution; that individuals whose researches are in any of the fields indicated are eligible; and that in case any chapter is in doubt regarding the eligibility of investigators, before election takes place the chapter should seek the opinion of the Executive Committee or of some of the officers authorized by the Executive Committee to act for it in such matters.

10. INITIATION OF MEMBERS IN ABSENTIA:

The Secretary presented an inquiry from the Pennsylvania Chapter regarding the proper method of procedure in the initiation of newly elected members and associates who resided at such distance from the chapter that they cannot present themselves for initiation at any meeting of the chapter.

The secretary was instructed to call the attention of the Chapter to Section 3 of Article V, of the Constitution which reads as follows:

"Should any member-elect or associate-elect be unavoidably absent from the general initiation, he may, at the pleasure of the Chapter, be provided with an opportunity to assent to pledge given in Section 2(c) and to sign the Constitution. The president shall then formally admit him to the Society, and shall present him with the certificate of membership."

11. BUDGET FOR 1930:

Treasurer Pegram presented the following budget:

Quarterly	$1800.00
Secretary's office	4400.00
Addressograph	760.00
Engrossing charters	150.00
Officers' travelling expenses	900.00
Treasurer's office	200.00
TOTAL	$8210.00

It was

Voted—To accept the budget as proposed.

12. MEETING ADJOURNED AT 1:30 P.M.

EDWARD ELLERY, *Secretary*

PROPOSED AMENDMENT TO THE CONSTITUTION

The Cornell Chapter proposes the following amendment to the Constitution to be acted upon at the next annual convention:

Be it resolved, that Article III, Section 3, of the Constitution be amended to read as follows:

Section 3. Eligibility: Members. The following, and no others, are eligible to election as members in a chapter at any institution: (*a*) *Any person of professorial or equivalent rank* in the institution who has shown noteworthy achievement as an original investigator in some branch of pure or applied science; (*b*) *any staff member of lesser rank*, or any student in the institution who, as judged by his actual work of investigation, has exhibited an aptitude for scientific research.

IN MEMORIAM

GUY LINCOLN NOYES, 1872–1930

Dean Noyes was a member of the faculty of the University of Missouri for twenty-eight years. For the last seventeen years he had been dean of the School of Medicine. Until his health failed he practiced medicine in Columbia, specializing in the eye, ear, nose, and throat. Both through his association with University affairs, through his contact with townspeople, and because of his interest in the affairs of the town, he had a host of warm friends in Columbia. His many former patients recall his sympathetic attitude and kindly interest that became personal with him in each case.

In addition to his many friends in the city he had a wide acquaintance in the state, and was held in high regard by the members of the medical profession. Few men in the state had done more for the advancement of the profession generally in Missouri than had Dean Noyes. Throughout his connection with the School of Medicine here he worked unceasingly for high standards for the school with the result that it enjoys an enviable record as a school of the two-year class.

Dean Noyes published a University bulletin on "The Relation of Sight and Hearing to Early School Life," an article in the Journal of the Missouri State Medical Association on "The Plan for Re-Establishing the Four Year's Course in the School of Medicine in the University," and an address on "Hospitals and Medical Service in Rural Missouri." He was a member of the Association of American Medical Colleges and of the American Medical Association, serving as vice-president of the Association of American Medical Colleges in 1927–28.

Dean Noyes was one of the founders of the Eugene Field Foundation for the Relief of Crippled Children and served as director in the organization until the time of his death. He was the "prime mover" in the Eugene Field movement and was largely responsible for putting the Foundation on its feet. He went before committees of the Legislature, working for legislation to provide appropriations for the care of the crippled children of the state. In the latter years of his life he was particularly interested in this project and gave it much attention

It was Dean Noyes who was responsible for the establishing of the

student health service in the University on the same basis as those in other universities. He was influential in obtaining appropriations for the construction of the University Hospital wing of the University Hospitals, and did much to make the plan and equipment for the new unit modern and complete.

Submitted by DEAN ALLEN, *University of Missouri*

CHAPTER OFFICERS

List Furnished by the Secretaries of the Chapters

Chapter	President	Vice-Pres.	Secretary	Treasurer
Cornell	F. O. Ellenwood	H. H. Love	W. A. Hagan	A. J. Heinicke
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